MARSH AND WATER MANAGEMENT PLAN
1995

PARKER RIVER NATIONAL WILDLIFE REFUGE
NEWBURYPORT, MASSACHUSETTS

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A. INTRODUCTION

Parker River National Wildlife Refuge (Refuge) was established in 1942 initially to protect and preserve migratory waterfowl. Today, the Refuge strives to preserve and maintain an optimal mix of natural and managed habitats for a diversity of migratory birds, endangered species, and indigenous wildlife species. Refuge wetlands provide habitat for waterfowl during the spring and fall migration, for wintering black ducks and Canada geese, and supports a small nesting population of dabbling ducks. Fall shorebird migrations are significant utilizing Refuge impoundments, salt pannes, and intertidal beach. A diversity of marsh and wading birds utilize Refuge wetlands for feeding and resting.

The 4,462 acre Refuge consists of over six miles of pristine barrier beach habitat, located on the southern two-thirds of Plum Island (attachment 1). Behind the beach and dune habitat lie extensive salt marsh (3,000 acres) interspersed with ditches, creeks, mudflats, and salt pannes. Two miles of dikes impound three rainfall-dependent freshwater wetlands (262 acres) which add diversity to the barrier island ecosystem. Approximately 88 acres of uplands, adjacent to wetland habitats, are maintained as open fields.

In addition to its primary emphasis, wildlife-oriented recreational use of the Refuge has been encouraged to the extent these activities are compatible with the purposes for which the Refuge was established. The area is a popular tourist attraction and the Refuge receives an estimated 250,000 visits annually for birdwatching, nature study, photography, surf fishing, clamming, waterfowl and deer hunting, environmental education, beach use, and other recreational activities.

B. PURPOSE

The three freshwater impoundments--North, Bill Forward, and Stage Island Pools were constructed by diking off salt marsh on the west side of the barrier island in the 1940's and 1950's to create habitat diversity in the barrier island ecosystem. All three impoundments are totally dependent on precipitation for their source of fresh water, thus diminishing management capabilities. Eutrophication, silting of channels and ditches, pest plant expansion, and general aging of the impoundments have seriously impacted the habitat diversity and wildlife value of them, particularly the North and Bill Forward Pools. Salt marsh habitat has been impacted by the extensive ditching conducted during the Depression years.

This Plan will provide a summary of the past and current marsh and water management program and will detail a proposed program for the short-term management of the Refuge impoundments and salt marsh

habitat. This Plan will also provide an outline for an organized approach to achieve long-range goals which require major rehabilitation, funding, and planning and development efforts.

C. OBJECTIVES

The marsh and water management practices detailed in this Plan are aimed at achieving the following objectives. These objectives are designed to support the overall goals of Parker River National Wildlife Refuge and the National Wildlife Refuge System.

1. Control pest plant vegetation in Refuge wetland.

2. Increase the habitat and vegetative diversity of the impoundments and ditched salt marsh for a diversity of migratory birds.

3. Implement shorebird management for the fall migration at selected impoundments.

4. Protect and enhance habitat for non-game birds, particularly those with decreasing populations.

5. Protect and manage wetland habitat for State and Federally-listed endangered species.

6. Prevent and control waterfowl disease outbreaks.

II. NORTH POOL

A. CURRENT PROGRAM

1. RESOURCES

Dike - This 100-acre impoundment (attachment 2) was created by construction of a dike in the 1940's and 1950's which effectively impounded this portion of the salt marsh estuary on the west side of Plum Island.

Soil - Soil borings taken in 1987 indicate that soil within the impounded area is primarily of the Ipswich group, a mucky peat, which is an indication of the Pool's former salt marsh status. The permeability of these soils is considered very rapid and is classified as susceptible to seepage when used for water management. High ground within the Pool consists of sand which is representative of back dune soils. The permeability in the sands is much lower.

Water Control Structures - North Pool has a water control structure, completed in 1988, which is a direct outlet to the saltwater estuary. The structure is a poured, reinforced concrete box with double stoplog configuration and two four-

foot diameter conduits. Flap gates were installed on the tidal side of the structure. This structure was constructed to improve water management capabilities, permit brackish water management, and to control pest plants with salt water intrusion. A metal culvert and concrete water control structure also exists on the crossdike between North and Bill Forward Pools. Originally built in 1952, both were replaced in 1983. Flowline elevation of the Pool is 2.10 feet and maximum elevation is 9.00 feet.

Water Source - North Pool has been totally fresh due to the lack of any direct water control structure with the saltmarsh until 1988. Precipitation and runoff from the surrounding uplands are the sole source of water for North Pool. The dike limits the amount of available runoff on the western side of the Pool. A maximum level of 7.6 feet above mean low water was cited in 1984.

Vegetation - The plant community in North Pool is illustrative of the major problems facing the rehabilitation efforts. Due to the lack of effective water management capabilities and management neglect, the Pool is dominated by extensive well-established monotypic stands (54 acres) of two pest plant species, purple loosestrife (Lythrum salicaria) and phragmites or common reed (Phragmites australis). The remaining vegetation (18 acres) is dominated by extensive stands of cattails (Typha spp.) interspersed with purple loosestrife. Following is a vegetative description from The Flora of Plum Island (McDonnell 1979): The Pools provide ideal conditions for the establishment of loosestrife which covers much of North and South Pools. Other plants forming large colonies in the Pools include cattail (Typha spp.) and phragmites. The dominant floating aquatics in the Pools are pondweed, (Potamogeton perfoliatus), sago pondweed (P. pectinatus), and duckweed (Lemna minor). Along the muddy shores extensive mats of spike rush (Eleocharis parvula) have formed.

The plant community is broken-up by a system of channels and ditches off of a main borrow ditch, located on the western side of the Pool adjacent to the dike. Approximately 20% of the Pool consists of open water, both shallow and deep. Submerged aquatic vegetation is limited.

Wildlife - North Pool provides habitat for breeding and migrating waterfowl, marsh and wading birds, and a diversity of other wildlife species. Winter use is limited due to ice conditions. A resident Canada goose population breeds in the Pool. Primary breeding waterfowl species include black duck, gadwall, and mallard, with small numbers of green and blue-winged teal, Northern pintail, Northern shoveler, and wood duck. Brood surveys indicate that waterfowl productivity and species diversity has declined dramatically in the Pools since

1991. This decline can be attributed to the general decline of the Pools and recent high predator populations of fox and skunk with corresponding predation of eggs and young. Historical Massachusetts Natural Heritage species once listed for the Pool include king rail, American bittern, least bittern, pied-billed grebe, and common moorhen. These species were absent in a vocalization survey conducted in Spring, 1992; however, pied-billed grebes and American bittern (in adjacent salt marsh) have been observed since. Other Heritage species including Virginia rail, marsh wren and green-backed heron were recorded on the survey. As many as 40 black-crowned night herons were observed leaving the Pool at dusk in 1992.

Fisheries - The fishery resources of the Pool are unknown. The resource may have been adversely impacted by past management practices and dominance of pest plants.

2. MANAGEMENT

Current and recent management has been directed at control of pest plants and increasing the habitat and vegetative diversity of the Pool for a variety of migratory birds, particularly waterfowl, and marsh and wading birds.

Dike Maintenance - Dikes are mowed annually to discourage waterfowl nesting because of the high risk of predation, and to control tree and shrub invasion. The stability of the dikes are checked periodically and repaired as needed.

Water Regimen - Because of the lack of a water source other than precipitation and runoff, objectives of the current water regimen are to hold as much water as possible. Water parameters are monitored as detailed in attachment 3.

Channelization - All the waterways in North Pool, many of which had silted in or were overgrown with vegetation, were widened and deepened with the amphibious "Cookie Cutter" in 1990. A ditch was created along the eastern side of the Pool with the Gemco Ditcher. This project improved water circulation, wildlife use, and habitat diversity. These back waterways are favored by waterfowl, and marsh and wading birds over the main borrow channel which receives disturbance from the Hellcat Swamp Observation area and staff use of the dikes. A canoe survey of the Pool in 1991 revealed that some of the channels, particularly north of the central bay area, had silted in again with large mats of floating muck.

Pest Plant Control:

Water Regimen - Partial drawdowns to 5.0 feet were conducted in 1991 and 1992 to adequately expose vegetation for late

summer herbicide treatment of pest plants and winter prescribed burning of treatment areas.

Herbicide - Because of the lack of water management capabilities and presence of long established pest plant stands, pest plant control is limited to the use of herbicides. Approximately 54 acres of monotypic stands of purple loosestrife and phragmites were treated with an aerial application of Rodeo in mid-August of 1991 and repeated in 1992. Treatment was complicated by the patchy distribution of the pest plant stands. Within the cattail stands interspersed with loosestrife, several strips of vegetation were also sprayed in 1991. Treatment of these cattail strips was not repeated in 1992 because of the extensiveness of the loosestrife and unfeasibility of treating the entire Pool. The loosestrife treatment area showed evidence of effective control in the growing season following herbicide application. Young growth was present in the understory; however, growth was delayed and not as vigorous as in previous years, particularly following the second year of treatment. Treatment of the phragmites stands was very effective with limited regrowth; however, a portion of the stand still remains which apparently was missed during the aerial application.

Prescribed Burning - An attempt was made to burn North Pool in March 1992 to remove dead herbicide treated vegetation and allow native plants to compete. Only an untreated cattail stand (12 acres) interspersed with loosestrife at the southern end of the Pool was successfully burned due to unfavorable weather conditions. The stand grew back primarily in cattail in 1992. The burn may have increased the vigor of the cattail allowing it to outcompete the loosestrife. A prescribed burn scheduled during the 1993 winter season was never accomplished due to failure to meet the weather prescription detailed in the Prescribed Burn Program.

Mowing - From the late 1950's until the early 1980's, purple loosestrife and phragmites on the drier portions of the Pools have been periodically mowed in late summer to create wildlife openings and foraging areas. According to Refuge Annual Narrative Reports, mowing during the period of flowering also helped to reduce pest plant dominance and allow other native plants to compete.

B. PROPOSED MANAGEMENT PROGRAM

Proposed management is directed at intensifying current management efforts to achieve previously listed objectives. Several of the

following programs will require submission of a Notice of Intent to the Newbury and Rowley Conservation Commissions under the Massachusetts Wetlands Protection Act. The Notice of Intent should address all permit activities on the Refuge on a five year basis.

Dike Maintenance - The stability of the dikes should be checked periodically. Muskrat holes should be filled in and bare spots seeded and mulched to prevent erosion. Dikes should be mowed annually to discourage waterfowl nesting due to predator use of the dikes and to control tree and shrub invasion.

Water Regimen - Because of the lack of a fresh water supply, precipitation and runoff will be held throughout the year at maximum levels; however, manipulation will be necessary for various pest plant control management activities detailed below. Complete drawdowns will be conducted every four years to aerate the marsh in order to stimulate plant growth, promote decomposition of organic matter, and expedite nutrient release, resulting in improved water quality. Drawdown will be coordinated with the other Pools so no two Pools are drawn down at any one time. Drawdowns should be carefully considered to avoid the spread of purple loosestrife on exposed mudflats. A phased dewatering is recommended to encourage native vegetation because if the Pool were emptied suddenly, the available mud flats may be quickly invaded by purple loosestrife. Any manipulations during the loosestrife growing season that might stress the native vegetation and allow loosestrife seedlings to spring up from dormant seed stocks should be avoided.

At the water control structure, impervious clay fill should be used in the space between the double stoplog bays to prevent leakage. Additional clay should be stockpiled nearby in a bin to replace clay lost to various factors including water level manipulation, leakage, and storms. Measurement of water parameters will continue as detailed in Management.

Channelization - All existing clogged and eutrophicated ditches and channels should periodically be cleaned with either the "Cookie Cutter" or Gemco Ditcher. Cleaning should be timed with completion of pest plant control, because decaying pest plant vegetation following herbicide treatment may cause the channels to silt back in negating the cleaning effort. Water levels should be at maximum levels to afford the amphibious "Cookie Cutter" the greatest access to all areas of the Pool. Channel cleaning will probably be required on a five year basis due to the stagnant condition of the Pool.

Mowing - During partial drawdowns conducted for management programs including herbicide application or when the ground is frozen, paths in the cattails could be mowed to create temporary wildlife openings and foraging areas.

Muskrat Eat-outs - Several bales of hay could be placed in various locations within dense cattail stands to encourage muskrat eat-outs.

Fisheries - Stocking with native fish may be necessary following control of pest plants. Fish sampling should be conducted to assess the need for stocking following completion of pest plant control using seining or electric shocking methods. Assistance could be requested from Massachusetts Audubon-North Shore and Marine Biological Lab, Woods Hole which are both conducting fish sampling in Plum Island Sound.

Pest Plant Control:

Complete eradication of purple loosestrife and phragmites is unlikely as the plants have been long established in the Pool. Historically, the earliest reference to loosestrife on the Refuge includes a Refuge memo to the New York Cooperative Wildlife Research Unit (11/20/68) which stated that in the early 1960's (1961-1965) loosestrife began to develop noticeably in the area including North Pool. By 1969, the Refuge Annual Narrative listed loosestrife as a dominant plant in North Pool. By 1979, McDonnell indicated that phragmites was present in large colonies in the impoundments and that loosestrife covered much of North Pool. The following combination of treatment methods is considered the most effective program to keep pest plants in check as a more integral part of the ecosystem.

Water Regimen - Any drawdowns must be carefully considered to avoid encouraging the spread of purple loosestrife on exposed mudflats from the existing seedbed and nearby plants. Drawdowns during late spring or early summer create more severe loosestrife infestation problems than do late summer or fall drawdowns (Rawinski 1982). Partial drawdowns will be necessary for various pest plant control activities including herbicide treatment and prescribed burning. Any negative effects of the drawdown will be mitigated by the long-term benefits of pest plant control which will significantly enhance the habitat diversity and value of the Pool for a variety of wildlife. Water levels will be drawn down to the minimum level necessary, approximately 5.0 feet, to adequately expose the vegetation. A drawdown for herbicide treatment must be at a level which will adequately expose the vegetation for treatment without causing stress which would reduce the effectiveness of Rodeo which functions through translocation. The drawdown will remain in effect in preparation for prescribed burning in the fall, contingent upon State approval, to adequately dry out the area. Stop logs should be replaced immediately after the management practice is completed.

Due to the lack of water management capabilities, it is not possible to prevent germination with flooding; however, maximum

spring water levels will help to delay germination of loosestrife seedlings. Summer seedling germination will not overtake native vegetation to the extent spring germination does (Rawinsky 1982).

Herbicide - Herbicide treatment of phragmites will probably need to be extended beyond the recommended two year program, initiated in 1991 and 1992, because the stands are so well established. The need for aerial treatment will be determined based on spring regrowth. Aerial treatment of monotypic stands of purple loosestrife is recommended for a longer term program than phragmites because the plant is such a prolific seed producer. The long established stands at North Pool will further complicate control measures. Once control of pest plants has been achieved, annual spot treatment will be critical to prevent reinfestation. Treatment programs at the Refuge have failed in the past because of a lack of long-term commitment and continuity. Spot treatment could be accomplished from tractors, boats, ATV and backpack tanks. One to two staff members should become State certified as pesticide applicators. It would be desirable to hire two temporaries for six to eight weeks annually to spot treat pest plants.

Plants will be treated with the herbicide Rodeo (EPA #524-343) at a rate of .5 gallons/acre in combination with .02 gallons of X-77 surfactant and 4.48 gallons of water. Herbicide treatment should be timed with full formation of the seed head in phragmites, typically mid to late August, and late bloom period of purple loosestrife, typically early to mid-August. It is believed that maximum translocation of aboveground photosynthate to an overwintering underground reserve is occurring at this time (Jones and Lehman). Treatment should be postponed if rain is forecast within twelve to twenty-four hours. A marker system should be devised to assist the contract pilot in defining the spray area and for reference points for the aerial transects. This may also be accomplished by accompanying the pilot (OAS certified) on a reconnaissance flight.

Prescribed Burning - Refer to the Annual Burn Programs for details. Monotypic stands of phragmites and loosestrife treated with herbicide should be prescribed burned the following fall or winter to release nutrients, open the canopy, expose the seed bed, and to prevent dead stems from intercepting herbicide the following year. Burning will also result in a flush of loosestrife growth from the seedbed and plants in the following spring which can then be treated with herbicide. The Refuge should pursue special permission from the MA Department of Environmental Protection, Air Quality Control to burn outside of the designated season in the fall. A fall burn within a few weeks of herbicide treatment would allow water levels to be held at maximum capacity throughout

the winter for the spring migration and nesting season. It would also allow scheduling of alternative winter mowing if a fall burn is not possible. If not approved, the burn should be scheduled as early as possible during the State designated burn season of January 15 through April 30 to allow for holding of maximum winter runoff and to allow for rescheduling due to the difficulty in meeting the weather prescription.

If it is not feasible to burn monotypic stands of both pest plants, loosestrife should have priority for burning over phragmites to encourage a flush of growth from seeds that can then be treated with herbicide the following year. Last priority for prescribed burning includes the areas of purple loosestrife interspersed throughout the cattail stands. A stand of cattail, heavily interspersed with loosestrife, which was prescribed burned in March 1992 grew back primarily in cattail the following season. The burn may have increased the vigor of the cattail allowing it to outcompete the loosestrife. This result was also evidenced in 1980, when a two-acre island of purple loosestrife was burned in late September. A site visit the following June revealed loosestrife growth in the burn area was considerably sparser than adjacent areas. Research suggests that cattail suppresses the growth of loosestrife under certain conditions (Rawinsky 1982).

Mowing - Winter mowing, when frozen ground conditions allow equipment access, will provide a back-up alternative to burning of herbicide treatment areas if staffing, equipment, or weather conditions do not allow for a burn. A rotary mower is preferable to a sickle bar to chop up the vegetation. Burning would still be more desireable and effective; however, mowing is a viable alternative.

The loosestrife dominated dike should be mowed annually during the time specified in herbicide application to stress loosestrife growth.

Plant Propagation - In spring, herbicide treated monotypic purple loosestrife stands located along the main channel should be seeded with Japanese millet. Because the stands are so well established and loosestrife is such a prolific seed producer, a viable seed bed is probably well established. Even treated plants will set some seed; however, viability is probably decreased by 50% by spraying (Purple Loosestrife Task Force). Millet will be planted as it can outcompete the loosestrife seedlings which will otherwise take root on the ideal germination conditions created by the prescribed burn. Japanese millet is a good temporary measure to forestall the establishment of loosestrife seedlings (Thompson et.al. 1987). It is expected that native cattail will predominate in subsequent years following pest plant control.

Seeded areas should be selected based on the presence of moist mudflat conditions created by previous burning or mowing. Seeding should be timed after the danger of frost is past, around mid to late May. Aerial seeding would be most efficient; however, planting could be accomplished by staff and volunteers walking transects with hand held rotary spreaders at a rate of 40 pounds per acre. The seeded area should then be dragged or raked to lightly cover the seeds.

Biological Control - The biological control methods of the Purple Loosestrife Working Group, Cornell University should be explored as ongoing research provides definitive answers on the feasibility of this method. It is unfeasible economically and undesirable biologically to treat the entire Pool since purple loosestrife is now well established in the extensive stands of cattail in addition to it's presence in dense monotypic stands which are easier to treat with herbicide.

Monitoring - Control methods should be monitored with annual color stereoscopic photos taken at the peak bloom period to be followed by cover mapping suitable for GIS application. Ground truthing of the photos will be necessary. Permanent vegetational transects should be established to closely monitor some of the vegetative changes that aerial photos might not disclose. At least three photo points should be established at each Pool and Kodacolor shots taken in mid-month from June through September.

C. LONG-RANGE GOALS

Future long-range goals address improving the water management capabilities and increasing habitat diversity of North Pool. Options discussed in the Master Plan (1983) and Waterfowl Management Evaluation (1989) include construction of a well as a fresh water source, subimpoundment into moist soil units, and creation of nesting islands as discussed below. Long-range goals will involve coordination with Engineering and Ecological Services. Preparation of any or all of the following may also be necessary: Environmental Assessment under the National Environmental Policy Act, US Army Corps of Engineer's (Corps) Section 404 Permit under the Clean Waters Act, and Notice of Intent under the Massachusetts Wetland Protection Act. Matching funding should be pursued from the National Fish and Wildlife Foundation, Ducks Unlimited-Marsh Program, the Service's North American Waterfowl Management Plan-Challenge Grant Program, and private or corporate sponsors.

Well - A study of the ground water and a proposed well field to supply North Pool with fresh water was completed in 1986 by Engineering. The proposed output of water was well below the amount needed to maintain the Pool. Other problems with power, pipelines and construction costs made this proposal unfeasible.

Subdivision - The subdivision of North Pool into smaller units with the potential to move water between units has also been explored in the past. The Waterfowl Management Evaluation proposed subimpounding the Pool into at least three units with one unit including the borrow pits, major central channels and open water area, and the water control structure. This would allow for the construction of at least two interior marsh subimpoundments that could be managed to better control pest vegetation without a complete reliance on herbicides, for moist soil management, and brood habitat. Management schemes could be alternated and limited fresh water stored and transferred between the units via simple CMP stop log risers and/or Crisifuli type pumps.
However, a Service Engineering report (12/8/86) concluded subimpoundment was unfeasible because "information suggests that the Pool may not be capable of holding a head of water over a sustained period of time". Water loss was attributed to transpiration and seepage. The North Pool soil is classified in the Soil Conservation Survey as susceptible to seepage when used for water management. A follow-up Engineering report (3/26/91) states "creating subimpoundments for the purposes of raising water levels within North Pool dike is not practical from an engineering perspective. To overcome the inadequacies of the existing soils, extensive amounts of money would have to be spent, with ultimate success very questionable." An alternative would be to construct a trial subimpoundment in the southern portion of the Pool in-house with regional equipment to test the feasibility of the project rather than relying solely on an evaluation obtained through testing and analytical calculations. Permits required for subimpoundment include a Corp's 404 Permit, and State Notice of Intent. An Environmental Assessment would also be required. The Refuge should consult with Engineering and Ecological Services staff.

Nesting Islands - Nesting islands could be created in conjunction with construction activities associated with subimpoundment.

II. BILL FORWARD POOL

A. CURRENT PROGRAM

1. RESOURCES

Dike - This 62-acre impoundment (attachment 4) was created by construction of a dike in the 1940's and 1950's which effectively impounded this portion of the salt marsh estuary on the west side of Plum Island.

Soil - The Soil Survey of Essex County indicates that soil within the impounded area is primarily Ipswich and Westbrook mucky peats, which is an indication of the Pools former salt

marsh status. The permeability of these soils is considered very rapid and is classified as susceptible to seepage when used for water management.

Soil samples taken in 1984 revealed the cause of the vegetation difference between the Forward and North Pool was found to be in the soluble salt levels-- 320 ppm and 65 ppm, respectively. The higher salt level has been attributed to leakage in the water control structure.

Water Control Structures - Bill Forward Pool has an antiquated water control structure which is a direct outlet to the saltwater estuary. The structure consists of a poured, reinforced concrete box with a single stoplog configuration and no tidal flapgate. Salt water intrusion has been a problem as during times of high tides, the structure has leaked, allowing saltwater into the impoundment. The water control structure in the drain mode is well above the pool bottom. Even with all the boards removed, 50% of the impounded area is under water. A metal culvert and concrete water control structure also exist on the crossdike between North and Bill Forward Pools. Originally built in 1952, both were replaced in 1983. Flowline elevation of the Pool is 4.60 feet and maximum elevation is 6.50 feet.

Water Source - Unlike North Pool, Bill Forward Pool is relatively brackish as a result of past management practices which introduced salt water and from leakage of the water control structure during storm tides. Bi-weekly salinity readings in 1992 and 1993 indicate a range in levels of 0-4 ppm. Precipitation and runoff from the surrounding uplands are the sole source of water for Forward Pool. The dike limits the amount of available runoff on the western side of the Pool. A maximum level of 6.55 feet above mean low water was cited in 1984. The Pool does not retain water adequately as water levels decline significantly after the spring rains.

Vegetation - The brackish nature of the Pool has reduced the amount of freshwater vegetation. Nearly the entire Pool is dominated by an extensive monotypic stand of phragmites (20 acres) for much of the same reasons as North Pool. The southern end of the Pool, on the western side, consists of a seasonally flooded field. This field is being overtaken by purple loosestrife as are the dikes.

The Pool lacks the system of smaller channels and ditches off its main waterway, as in North Pool. Approximately 50% of the Pool is open water. Submerged aquatic vegetation is limited.

Wildlife - The Forward Pool is much shallower than North Pool and therefore more heavily used by shorebirds and wading birds; however, it is also used by waterfowl and a diversity of other wildlife. Shorebird use of the Pool is heavy in the summer as

water levels gradually recede exposing the shoreline and mudflats for feeding. The lower water levels are also favored by wading birds with as many as 200 snowy egrets observed roosting in the Pool in late August and September. American bitterns, a Massachusetts Natural Heritage Species, were observed in the Pool in 1993. During a wet spring, the field becomes flooded for a short period of time and is heavily used by waterfowl. Waterfowl breeding use and recent decline is summarized in North Pool.

Fisheries - The fishery resources of the Pool are unknown. The resource may have been adversely impacted by past management practices and dominance of pest plants.

2. MANAGEMENT

Current and recent management has been directed at control of pest plants and increasing the habitat and vegetative diversity of the Pool for a variety of migratory birds, particularly shorebirds, and marsh and wading birds, and waterfowl.

Dike Maintenance - Conducted as detailed in North Pool.

Water Regimen - Because of the lack of a water source other than precipitation and runoff, objectives of the current water regimen are to hold as much water as possible. In the past, water levels were seasonally lowered and the Pool then partially reflooded with small quantities of sea water to encourage the growth of certain beneficial plants and organisms and, to a degree, to control salt-intolerant pest plants (Master Plan 1983). However, this management practice has been discontinued because of concerns for impacts to native freshwater vegetation and lack of a fresh water source to flush salinity from the Pool.

Water parameters are monitored as detailed in North Pool.

Channelization - A ditch was excavated along the entire east side of the Pool in 1990 with the Gemco Ditcher. The ditch was created as a fire line for prescribed burning and to afford waterfowl more wetland habitat.

Pest Plant Control:

Water Regimen - A partial drawdown was not necessary for the mid-August 1992 herbicide treatment as water levels were nearly one foot below the desired 5.0 foot level.

Herbicide - Because of the lack of water management capabilities and presence of well established monotypic

stands of phragmites, pest plant control is limited to the use of herbicides. In mid-August 1992, the entire stand of phragmites (20 acres) was treated and the seasonally flooded western portion of the Forward field, located at the southern end of the Pool. The entire field has been invaded by purple loosestrife; however, the upland eastern portion of the field will be mowed annually during the peak bloom period to stress the loosestrife. Research indicates repeated mowing is an effective means of reducing loosestrife infestations in pastures (Thompson et.al. 1987). Herbicide treatment of the phragmites was nearly 100% effective; however, several small isolated stands which were missed during the aerial application remain.

Prescribed Burning - Although burning of herbicide treatment areas is preferable to mowing, the decision was made to mow Forward Pool with a rotary mower the following winter. This decision was based on the difficulty of meeting the weather prescription to burn all three impoundments in one season. Priority was placed on North and Stage Island Pools because Forward Pool is more suitable for mowing which is a viable back-up alternative.

Mowing - Conducted as detailed in North Pool. In addition, a portion of the herbicide treated phragmites was mowed in February 1993 to remove standing dead vegetation and allow native plants to compete.

Salt Water Intrusion - Salt water was introduced in the summer of 1968 and 1969 in an effort to control purple loosestrife which was dominant in the Pool at that time. The plant was killed on an annual basis; however, final determination of the effectiveness of salt water as a long term control of loosestrife remained to be established. The Annual Narrative stated that salt water flooding was useful in killing stands of mature plants; however, regrowth and particularly seedling development each year has recurred and suggests a strong adaptive ability is found in the plant which gives it a remarkable tolerance for survival under a wide range of environmental conditions.

B. PROPOSED MANAGEMENT PROGRAM

Proposed management is directed at intensifying current management efforts to achieve previously listed objectives. Several of the following programs will require submission of a Notice of Intent to the Rowley Conservation Commission under the Massachusetts Wetlands Protection Act. The Notice of Intent should address all permit activities on the Refuge on a five year basis.

Dike Maintenance - Conducted as detailed in North Pool.

Water Regimen - Water levels and water parameters will be conducted as detailed in North Pool. Drawdowns should be carefully considered because a loosestrife seedbed is probably well established in the Pool from past dominance of the plant. In addition, since this Pool has been shown to be favored by shorebirds, and since it does not appear capable of maintaining water levels, and since salinity has limited options for management for emergent waterfowl food plants; efforts should be focused towards shorebirds. As the southward migration begins in mid-July, a very gradual drawdown to continually expose mudflats around the perimeter of the Pool should be conducted until the migration ends in early September. However, a slow dewatering to make new foraging habitat available continuously for fall migrating shorebirds may not be necessary because of the Pools inability to hold water which results in naturally declining water levels throughout the summer.

A dye test should be performed to determine if water is leaking through the water control structure or dike.

Channelization - The ditch along the eastern edge of the Pool, created in 1990, should be cleaned with the Gemco ditcher as detailed in North Pool.

Fisheries - Conducted as detailed in North Pool.

Pest Plant Control:

Complete eradication of purple loosestrife and phragmites is unlikely as the plants have been long established in the Pool. Historically, a Refuge memo to the New York Cooperative Wildlife Research Unit (11/20/68) indicated that loosestrife became a dominant plant in the Pool in 1965 following cessation of an annual farming program which involved plowing and discing followed by planting of Japanese millet. By 1979, McDonnell indicated that phragmites was present in large colonies in the impoundments and that loosestrife still covered much of Bill Forward Pool. At some point, phragmites became the dominant plant overtaking the entire Pool. The following combination of treatment methods is considered the most effective program to keep pest plants in check as a more integral part of the ecosystem.

Water Regimen - Conducted as detailed in North Pool; however, partial drawdowns for various pest plant control activities will usually not be necessary because of the inability of the Pool to hold water.

Herbicide - Treatment of monotypic stands of phragmites will be conducted as detailed in North Pool. The program, initiated in 1992, will probably need to be extended beyond the recommended

two years because the stands are so well established in the Pool.

Prescribed Burning - If time permits the herbicide treated phragmites stands should be prescribed burned in the winter as detailed in North Pool. Treatment areas at North and Stage Island Pool have priority over Forward Pool since mowing is a viable alternative here.

Mowing - Winter mowing will provide an alternative to burning of herbicide treatment areas if staffing, equipment, or weather conditions do not allow for a burn. A rotary mower is preferable to a sickle bar to chop up the vegetation. Burning would still be more effective; however, mowing is a viable alternative because of the accessibility of the phragmites stands in the Forward Pool.

The loosestrife and phragmites dominated dike and the entire loosestrife dominated field should be mowed annually at peak bloom and peak tassel formation, respectively, to discourage pest plant growth. Historical annual Narrative Reports and research indicate long-term mowing is effective (Cross and Fleming 1989, Thompson 1989). The effectiveness of mowing was also confirmed in 1993 when phragmites stands mowed the previous year during peak tassel formation showed evidence of stress. The vigor of the mowed stands, located along the roadsides and edge of Cross Farm Hill, was severely reduced in both height and density.

Plant Propagation - Although phragmites can outcompete any plantings, it may be necessary to plant Japanese millet as a loosestrife seedbed is probably well established in the Pool as well as recolonization from the adjacent field. Planting in the herbicide treated phragmites area will be conducted as detailed in North Pool.

Biological Control - The biological control methods of the Purple Loosestrife Working Group should be explored for the loosestrife dominated field as detailed in North Pool.

Monitoring - Conducted as detailed in North Pool.

C. LONG-RANGE GOALS

Future long-range goals address improving the water management capabilities and increasing habitat diversity of Bill Forward Pool. Options discussed in the Master Plan (1983) include construction of nesting islands and application of a seal along the borrow ditch, along with others are detailed below. Refer to North Pool for coordination, permit requirements, and funding options.

Water Control Structure - The water control structure should be replaced with a design similar to North Pool to prevent salt water intrusion and leakage of valuable water supply, and to allow for complete drainage of the Pool for various management practices.

Salinity - Soil tests should be repeated and salinity assessed as to its potential effect on fresh water and in turn, submerged aquatic vegetation. Removal of salinity from the soil should be addressed if tests indicate a problem exists. A corrective management program may involve plowing. Because of the lack of a fresh water source, the salt can not be flushed out.

Subimpoundment - The southern portion of the Pool which consists of a seasonally flooded field can be impounded with a low-level dike system for moist soil management. The dikes could be constructed in-house with Regional equipment. Water retention capabilities of the soil should be tested and the rate of evapotransporation calculated to determine the feasibility of this project as the remainder of the Pool does not appear capable of holding water for any length of time.

Borrow Pit Sealage - Seepage in the Forward Pool could be controlled by applying a seal along the borrow pit adjacent to the dike. This would enable more effective conservation of water and enhance water level management capability. Engineering should confirm if water leakage occurs in the borrow pit and also determine if the problem occurs in the remainder of the Pool as well; however, the cost of a seal may be prohibitive. If water holding capabilities are increased, the Refuge should implement slow dewatering during the fall shorebird migration from mid-July through early September.

Nesting Islands - Islands could be created in conjunction with various construction projects including subimpoundment or plowing.

III. STAGE ISLAND POOL

A. CURRENT PROGRAM

1. RESOURCES

Dike - This 100-acre fresh water impoundment (attachment 5) was created by construction of a dike in the 1940's and 1950's which effectively impounded this portion of the salt marsh estuary on the west side of Plum Island. The dike was rip-rapped with stone in 1988 to reduce erosion caused by wave action.

Soil - The Soil Survey for Essex County indicates that soil within the impounded area is primarily Ipswich and Westbrook mucky peats, an indication of the Pool's former salt marsh

status. The permeability of these soils is considered very rapid and is classified as susceptible to seepage when used for water management.

Water Control Structure - Stage Island Pool has a water control structure which is a direct outlet to the salt water estuary. The old corrugated metal pipe structure was replaced with a larger, reinforced concrete structure in 1988, identical to North Pool, to allow controlled use of saltwater in pest plant management, to improve water management capabilities, and to permit brackish water management. The previous water control structure leaked resulting in salt water intrusion during periods of high tide. Flowline elevation of the Pool is 1.50 feet and maximum elevation is 7.50 feet.

Water Source - Stage Island Pool has the most water of the freshwater impoundments and retains water well throughout the summer. Precipitation and runoff from the surrounding uplands are the sole source of water for the Pool.

Vegetation - Stage Island Pool is the most diverse of the freshwater impoundments. A high degree of edge habitat (water interspersed with several islands and peninsulas) and both shallow and deep open water areas create a variety of habitats for wildlife. Vegetation is similar to North Pool; however, with greater diversity, probably as a result of pest plant control several years ago. Extensive monotypic stands of phragmites (45 acres) are expanding and threatening to overtake the Pool for much of the same reasons as North Pool and purple loosestrife has recently became prevalent, interspersed in the extensive cattail stands.

Wildlife - Despite the presence of pest plants, the Pool supports the greatest diversity of waterfowl, wading birds, and shorebirds of the three Pools. Shorebirds made extensive use of exposed mudflats throughout 1991 when the Pool was drawn down for the lead shot plowing. Following completion of the plowing and a return to full water capacity; the response by waterfowl and shorebirds was excellent with birds feeding extensively in the shallowly flooded plowed areas. Waterfowl breeding use and recent decline is summarized in North Pool. Historical Massachusetts Natural Heritage species once listed for the Pool include those listed for North Pool. These species were absent in a vocalization survey conducted in Spring, 1992; however, other Heritage species including Virginia rail and marsh wren were recorded. Pied-billed grebes were also observed in 1993.

Fisheries - Conducted as detailed in North Pool.

2. MANAGEMENT

Current and recent management has been directed at control of pest plants and elimination of the toxic lead shot problem in the soil. Management has also been directed at increasing the habitat and vegetative diversity of the Pool for a variety of migratory birds, particularly waterfowl, and marsh and wading birds, and shorebirds.

Dike Maintenance - Conducted as detailed in North Pool.

Water Regimen - In past years, high water levels have been maintained in spring to produce waterfowl territorial, brood rearing, and nesting cover in the form of small islands and emergent stands of vegetation surrounded by open water. In summer, water levels have been either reduced to encourage vegetational growth, or kept as high as possible to preserve already ideal growth and to discourage the spread of loosestrife. In fall, rainfall is usually held to refill the Pool for the next spring. However, following a major winter Canada goose die-off in 1983-84, the Pool has been drained annually in late summer to discourage geese from feeding in the lead shot contaminant area. In 1990 and 1991, water management in Stage Island Pool was conducted in conjunction with mechanical operations to plow under toxic lead shot in the Pool. As in Forward Pool, water levels have been lowered and the Pool then partially reflooded with small quantities of sea water (Master Plan 1983); however, this practice is no longer continued due to negative impacts on native freshwater vegetation and lack of a fresh water source to flush salinity from the Pool.

Water parameters are monitored as detailed in North Pool.

Channelization - All the natural waterways and drainage ditches were cleaned out and widened with the amphibious "Cookie Cutter" in 1990. The Gemco Ditcher was then used to connect them with wet spots located in the upper reaches of the Pool to allow for better drainage for the lead shot plowing.

Pest Plant Control:

Water Regimen - Partial drawdown to 5.0 feet was conducted in mid-August, 1992 to adequately expose vegetation for aerial herbicide treatment of pest plants. Water levels were restored for the fall migration and again partially drawndown in early winter in anticipation of prescribed burning of treatment areas.

Herbicide - Because of the lack of water management capabilities and presence of long established pest plant stands, pest plant control is limited to the use of herbicides. Rodeo was aerially applied to the Pool in August, 1987 to control phragmites and purple loosestrife,

and was somewhat effective; however, the program was not continued and pest plants returned. Approximately 45 acres of monotyic stands of phragmites, located along the Pool edges and isolated islands, were treated with an aerial application of Rodeo in mid-August of 1992. Treatment was complicated by the patchy distribution of the pest plant. Loosestrife interspersed within extensive cattail stands was not treated because of the extensiveness of the loosestrife. The herbicide was nearly 100% effective; however several small isolated patches remain which were missed during the aerial application.

Prescribed Burning - A prescribed burn of phragmites and purple loosestrife was conducted in April 1985. Two attempts to burn the 1987 herbicide treatment areas were made in March and November, 1988. The March burn was canceled due to wind and only 25-30% of the Pool was burned in November because the fuel moisture was too high. The 1992 herbicide treatment areas were not burned the following winter as planned because of a failure to meet the weather prescription as detailed in the Annual Burn Program.

Lead Shot Management - The western and southern sides of the Pool share a common boundary with Sandy Point State Reservation. For years before Federal law mandated the use of steel shot, hunters shooting from the State property deposited high concentrations of lead shot in the top four inches of soil which extended 800 feet into the Pool. During the 1990 fall season, the Pool was drained and a contractor plowed approximately 50% of the contaminated area to a depth of twelve inches; returning in the 1991 fall season to complete the work. The Pool remained drawn down throughout most of 1991 to accomplish two goals: 1) to aerate the marsh in order to stimulate plant growth, promote decomposition of organic matter, and expedite nutrient release, resulting in improved water quality and 2) to allow the contractor to return to complete the plowing. The project appears to have been successful with no evidence of lead poisoning observed in waterfowl which utilized the Pool since completion of the plowing. Samples from a test plot, salted with steel shot and plowed under to a depth of twelve inches in 1991, revealed no evidence of steel shot in the upper four inches of soil in 1992.

B. PROPOSED MANAGEMENT PROGRAM

Proposed management is directed at intensifying current management efforts to achieve previously listed objectives. Several of the following programs will require submission of a Notice of Intent to the Ipswich Conservation Commission under the Massachusetts Wetlands Protection Act. The Notice of Intent should address all permit activities on the Refuge on a five year basis.

Dike Maintenance - Conducted as detailed in North Pool.

Water Regimen - Conducted as detailed in North Pool.

Channelization - Conducted as detailed in North Pool.

Fisheries - Conducted as detailed in North Pool.

Pest Plant Control:

Complete eradication of purple loosestrife and phragmites is unlikely as the plants have been long established in the Pool. Historically, the 1969 Annual Narrative stated phragmites was present in the Pool and loosestrife to a lesser degree. The Master Plan (1983) stated because of a better water supply and retention in Stage Island Pool compared to the other Pools, loosestrife was not yet dominant. However, loosestrife became prevalent, interspersed within the cattail, following a year of complete drawdown in 1991. The following combination of treatment methods is considered the most effective program to keep pest plants in check as a more integral part of the ecosystem.

Water Regimen - Conducted as detailed in North Pool.

Herbicide - Treatment of monotypic stands of phragmites will be conducted as detailed in North Pool. The program, initiated in 1992, will probably need to be extended beyond the recommended two years because the stands are so well established and treatment is complicated by the patchy distribution of the stands.

Prescribed Burning - Burning of herbicide treated phragmites stands and untreated cattail stands interspersed with loosestrife will be burned as detailed in North Pool.

Mowing - Winter mowing of herbicide treated phragmites stands, as a back-up alternative, will be conducted as detailed in North Pool.

Plant Propagation - Planting may not be necessary because of the diversity of the Pool and resultant natural seedbed. If planting of the herbicide treated phragmites stands is necessary, it will be conducted as detailed in North Pool.

Biological Control - Control of loosestrife interspersed within the cattail will be conducted as detailed in North Pool.

Monitoring - Conducted as detailed in North Pool.

Plant Propagation - The southern end of the impoundment adjacent to the State Reservation (lead shot plow area) should be plowed under and planted with Japanese millet in the spring, then shallowly

reflooded. This area was heavily used by waterfowl and wading birds following shallow flooding of the lead shot plow area in 1992. Water levels will be partially drawndown prior to the planting and then the Pool allowed to refill. Planting would have to be contracted out aerially or with a specially equipped tractor. Planting should not be considered until purple loosestrife is under control as partial drainage may encourage undesirable growth.

C. LONG RANGE GOALS

Because of the natural character and diversity of Stage Island Pool, it is recommended that the Pool be left in its natural state with no major alterations planned. This recommendation is also consistent with the Master Plan and Waterfowl Evaluation which did not propose any major alterations beyond what has already been accomplished.

IV. SALT MARSH

A. CURRENT PROGRAM

1. RESOURCES

Vegetation - The salt marsh portion of the Refuge consists of approximately 3,000 acres of spartina grasses interspersed with creeks, mudflats, pannes, and an extensive system of ditches. The low marsh community is dominated by the tall form of saltwater cordgrass (Spartina alterniflora) with the short form occurring on the upper levels. The high marsh community is dominated by salt meadow cordgrass (S. patens) and salt grass (Distichlis spicata). Interspersed with the grasses are herbaceous species including sea lavender (Limonium nashii), sea blite (Suaedea spp.), glasswort (Salicornia europaea), and sea orach (Atriplex patula). Much of the Refuge marsh is dominated by the high marsh community, except in hollows and along creeks, where saltwater cordgrass survives. Along the upper edge of the high marsh, black grass (Juncus geradii) often forms pure, or nearly pure, stands.

The marsh was extensively ditched in the past to control mosquito populations and/or drain for salt marsh hay production. Several of the ditches have naturally filled, restoring some of the former salt pannes, particularly at the Salt Pannes Wildlife Observation Area between Boardwalks #2 and #3. Pannes with relatively good water exchange contain widgeon grass (Rupia maritima) and occasionally eelgrass. They are bordered by saltwater cordgrass, usually the tall form. Pannes higher up on the marsh, having poor exchange with the bay water, develop high salinities which eliminate all but the most salt resistant plants such as glasswort. The marsh is part of

the largest salt marsh system north of Long Island Sound.

Wildlife - The salt panne system is extremely valuable to a variety of fish and wildlife species. A diversity of waterfowl, shorebirds, and wading birds benefit from this system. The Refuge hosts large numbers of shorebirds during the fall migration and wintering black ducks which depend on this habitat. It also serves as a valuable spawning and nursery area for many of the major marine food sources. Eight of the twelve fish species most important to local commercial and sport fisheries are dependent on these tidal wetlands, particularly the salt panne system.

2. MANAGEMENT

Management is primarily through protection, restoration, and enhancement of the salt marsh ecosystem for waterfowl, shorebirds, and wading birds, as well as other organisms in the biological community.

OMWM/Salt Marsh Restoration - Open Marsh Water Management (OMWM) offers an excellent opportunity for long-term biological control of mosquitos and restoration of ditched salt marsh. OMWM relies on a system of inter-connecting pannes that permit fish to move into shallow areas to feed where mosquitoes breed and then to return to the deeper pannes when the temperatures rise or the shallow pannes dry out. In 1991, the Refuge entered into a Cooperative Agreement with the Essex County Mosquito Control Project (ECMCP) to implement OMWM activities on Refuge salt marsh. The ECMCP provides matching funding in the form of staffing, expertise, and equipment. ECMCP has fine-tuned OMWM techniques for New England marshes and has the specialized equipment, which is extremely costly, available to accomplish the project. ECMCP also obtains the necessary permits from the Army Corps of Engineers. State and local permits are not required as ECMCP is exempt. The cooperative effort benefits both agencies with the Service achieving objectives of restoration and enhancement of ditched salt marsh which directly benefits migrating and wintering waterfowl, migrating shorebirds, and resident wading birds. The effort also eliminates the need for pesticides. ECMCP achieves their objectives of long-term biological control of mosquitoes on previously inaccessible lands. The Refuge is in the third year of the cooperative agreement. Two sites were completed (11

acres) in 1991 and 1992 with successful results. Monitoring of a third site has begun for 1993.

The project is conducted based on the Standards for OMWM, Essex County developed by ECMCP (attachment 6). ECMCP provides pre-site monitoring, site plans detailed on aerial photos, and site implementation. Parameters which are monitored include

mosquito larvae, flooding events, rainfall, adult mosquito, mosquito identification, water temperature, salinity, and dissolved oxygen, fish populations, shorebird activity, and human activity. ECMCP also monitors the success of the restoration for a period of two years and provides corrective repairs as needed to sustain the viability of the restored wetlands. The project is documented with annual aerial photographs. The program consists of plugging of man-made ditches, restoration of drained pannes, excavation of reservoirs, creation of nesting islands from excavation material, and excavation of new channels and old channels between isolated pannes. Construction is accomplished with a specialized Smalley tractor, which exerts only 1.7 lb/in2 ground pressure thus minimizing impacts to the marsh, and a rotary ditcher. OMWM methods are detailed below:

Ditch Plugs - Existing man-made ditches are selectively plugged so as to restore the historic natural character of the salt marsh. Grid-ditches that dewater salt marsh pannes are plugged using OMWM techniques to restore natural pond water heights on the salt marshes. Ditch plugs, at least 50 feet in length, are placed near where the ditches enter the ponds. Plugs are made with on-site, marsh-derived spoil obtained from associated OMWM efforts such as excavations of sumps in ponds. Initial plug height in old grid-ditches are several inches above the adjacent marsh surface to allow for settling of the plug material over time.

Pannes - In conjunction with selective plugging of ditches which have dewatered pannes to restore natural pond water heights; pannes will be utilized where depressions exist and will take the shape of existing depressions. Panne sides will gradually slope upward from the deep sumps to one foot or less at the edges to promote wading bird, shorebird, and waterfowl use.

Sumps - To insure that the pannes do not become so dry that all insectivorous minnows die during drought or neap tides, sumps 24 to 36 inches deep may be excavated within the ponds. These sumps may cover up to 10% of a pond's bottom surface area. The spoil from sump excavations will be used to make grid-ditch plugs; will be spread by a rotary ditcher in a thin, even layer at a depth of one to three inches for 30 to 50 feet over the marsh so an not to alter its character; or stored at an upland site. The sumps will not only help insure minnow survival during low water but will also provide permanently deep areas to maintain patches of submerged aquatic vegetation such as widgeon grass. If the panne bottoms are adequately firm for a high flotation backhoe, the sumps will be excavated in the panne centers; if the panne bottoms are too soft, the sumps will be excavated along the panne edges, keeping the machinery on more consolidated grassy areas.

Channels/Ditches - New channels may be excavated and old channels and ditches restored between isolated pannes. Natural channels and man-made ditches tend to fill in over a period of years due to slumping sides and from detritus and other plant materials making it necessary to periodically clean out these waterways. The new and/or restored ditches and channels will not exceed 1 to 1.5 feet wide and deep. This would increase the interspersion of land and water areas, thereby increasing the edge effect and facilitating access for waterfowl and other wildlife. This technique will also restore water circulation within the marsh thus also improving access for mosquito eating fish to formerly isolated pannes. The spoil material will be used for ditch plugs, will be evenly spread in a thin layer over the marsh so as not to alter the vegetational composition, or stored at an upland site.

Nesting Islands - Nesting islands are created based on two techniques. They are 1) panne excavation material which is still vegetated is deposited in pannes, and 2) islands of vegetation are left in former pannes which are excavated. Islands are kept at levels consistent with marsh topography so as to prevent colonization by upland species.

B. PROPOSED MANAGEMENT PROGRAM

OMWM/Salt Marsh Restoration - The Refuge will continue to pursue Challenge Grant and Wetlands Restoration funding to continue the cooperative agreement with ECMCP. The project will continue based on techniques detailed above.

C. LONG-RANGE GOALS

OMWM/Salt Marsh Restoration - Plans for the future include expansion of the program to incorporate larger sites and additional funding cooperators. Possible cooperators include Massachusetts Division of Fisheries and Wildlife, Ducks Unlimited, and Massachusetts Audubon. Plans also include pursuing North American Waterfowl Management Plan Challenge Grant, Ducks Unlimited Marsh Program, and/or National Fish and Wildlife Foundation funding to purchase the specialized OMWM equipment. A possible matching cooperator includes ECMCP. The equipment could also be purchased jointly by several New England refuges interested in OMWM. Eventual plans include training of Refuge staff in OMWM techniques. Additional staff would be required. The Refuge would have to pursue the necessary local, State, and Federal permits if conducting OMWM separately from ECMCP.

OMWM/Salt Marsh Restoration Research Needs - The Refuge should submit an IPW to fund a study on the wildlife and vegetational response to OMWM/Salt Marsh Restoration. The University of New Hampshire and University of Massachusetts, Amherst should be

contacted to determine their interest in a research project. Challenge Grant funding should be pursued to match University funding.

IV. REFERENCES

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ATTACHMENTS

1. Parker River National Wildlife Refuge Map
2. North Pool Aerial Photo
3. Impoundment Water Parameters
4. Bill Forward Pool Aerial Photo
5. Stage Island Pool Aerial Photo
6. Standards for OMWM, Essex County, Massachusetts